Chen-Northern, Inc.

Final

FIELD SAMPLING PLAN FOR A PHASE II SITE INVESTIGATION

BLOCK P MILL AND BLOCK P MINE OPERABLE UNITS ENGINEERING EVALUATION/COST ANALYSIS

HUGHESVILLE/BARKER MINING DISTRICT JUDITH BASIN AND CASCADE COUNTIES, MONTANA

Consulting Engineers and Scientists

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JUDITH BASIN AND CASCADE COUNTIES, MONTANA

Prepared for:

Abandoned Mine Reclamation Bureau
Montana Department of State Lands
Helena, Montana

Prepared by:

Chen-Northern, Inc.
Helena, Montana

May, 1991

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1.0 INTRODUCTION

Chen-Northern, Inc. (Chen-Northern) personnel prepared this field sampling plan (FSP) to describe proposed field activities to be completed in conjunction with a Phase II field investigation at the Block P Mill Tailings and Block P Mine Operable Units (OUs) in the Hughesville/Barker Mining District. Chen-Northern completed initial field investigations in the District during the fall of 1990 in conjunction with the preliminary assessment of the area (Chen-Northern, 1991).

The Abandoned Mine Reclamation Bureau (AMRB) has elected to complete an engineering evaluation/cost analysis (EE/CA) of the two highest priority OUs in the mining district as determined through the PA process (Chen-Northern, 1991). These OUs include the Block P Mill tailings and the Block P Mine and associated waste dump. Certain gaps in the data available for each OU were identified that need to be filled prior to completing EE/CAs (Memorandum from M. Grotbo to S. McAnally, April 2, 1991). This field sampling plan was developed to fill these data gaps.

1.1 OBJECTIVE OF THE FIELD SAMPLING PLAN

The objective of this field sampling plan (FSP) is to present a detailed description of all field investigatory activities that will be performed to support completion of EE/CAs for the Block P Mill OU and the Block P Mine OU. The purpose of this field sampling program is to gather environmental data to provide a more complete basis from which subsequent reclamation alternative evaluations can be completed for these two OUs.

This plan is a companion document to the memorandum described previously and the quality assurance project plan, community relations plan, and health and safety plan developed for the preliminary assessment of the site (Chen-Northern, 1990a, 1990b, and 1990c). These documents are hereby incorporated by reference to address the various requirements of documentation germane to completing field activities under this Phase II investigation. Chen-Northern personnel completing work during the Phase II investigations will refer to appropriate portions of these documents when seeking guidance on field and

laboratory protocol for this project. This field sampling plan, therefore, represents the only unique document for guiding the Phase II investigation.

1.2 SITE BACKGROUND

1.2.1 Location

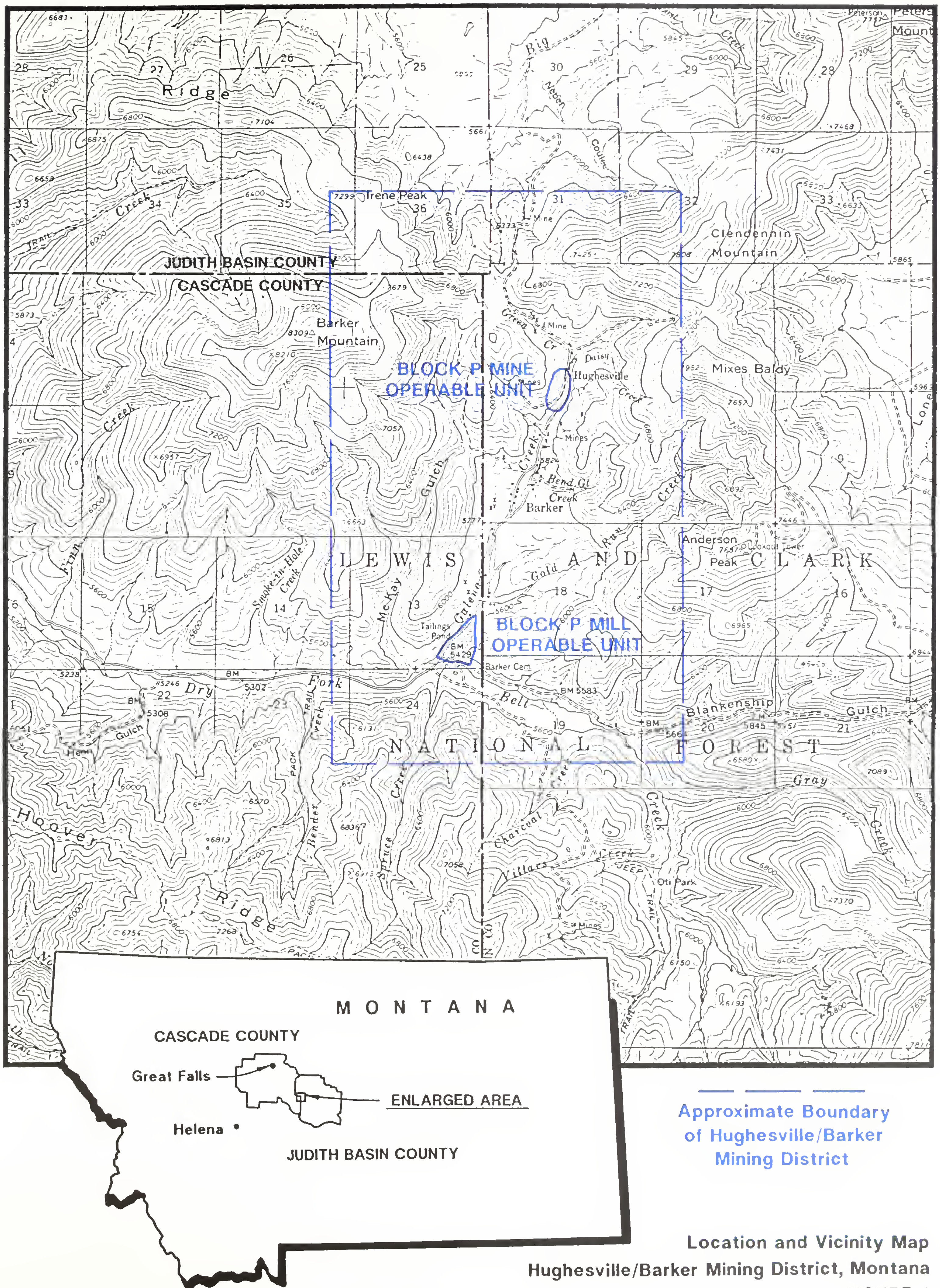
The Block P Mill OU and the Block P Mine OU are located in the Hughesville/Barker Mining District within the Galena Creek drainage of north-central Montana (Figure 1). The Galena Creek drainage is located approximately 10 miles east of Monarch, Montana. The site is accessed via U.S. Forest Service Road No. 120 which joins with Montana Highway 89 near Monarch.

1.2.2 Regulatory Background

The Abandoned Mine Reclamation Bureau (AMRB) of the Montana Department of State Lands (DSL) is the lead agency for the investigations of the Block P Mill and Block P Mine OUs. The AMRB receives its appropriations from the Federal Office of Surface Mining (OSM) via a tax levied on the nation's coal producers. The U.S. Forest Service (USFS) has a vested interest in the activities completed by the AMRB within certain portions of the mining district. The USFS administers most of the land occupied by the Block P Mill OU.

The Montana Department of Natural Resources and Conservation (DNRC) completed a study in the area during the 1970's in support of their reclamation efforts at the Block P Mine dump. Data collected during this study (DNRC, 1977) indicated that Galena Creek water quality is severely impacted by the presence of mine wastes in the area and adit and shaft discharges. Relatively high concentrations of several metals were measured in both Galena Creek and in point source inputs to the stream.

The AMRB completed a hazardous mine opening inventory in the district during the late 1980's. This inventory provides information on locations of mine waste sources, adits, and



Location and Vicinity Map
Hughesville/Barker Mining District, Montana
FIGURE 1

shafts. The AMRB also completed a preliminary environmental assessment of the Block P Mill OU to support a construction grant application through OSM (MSE, 1991).

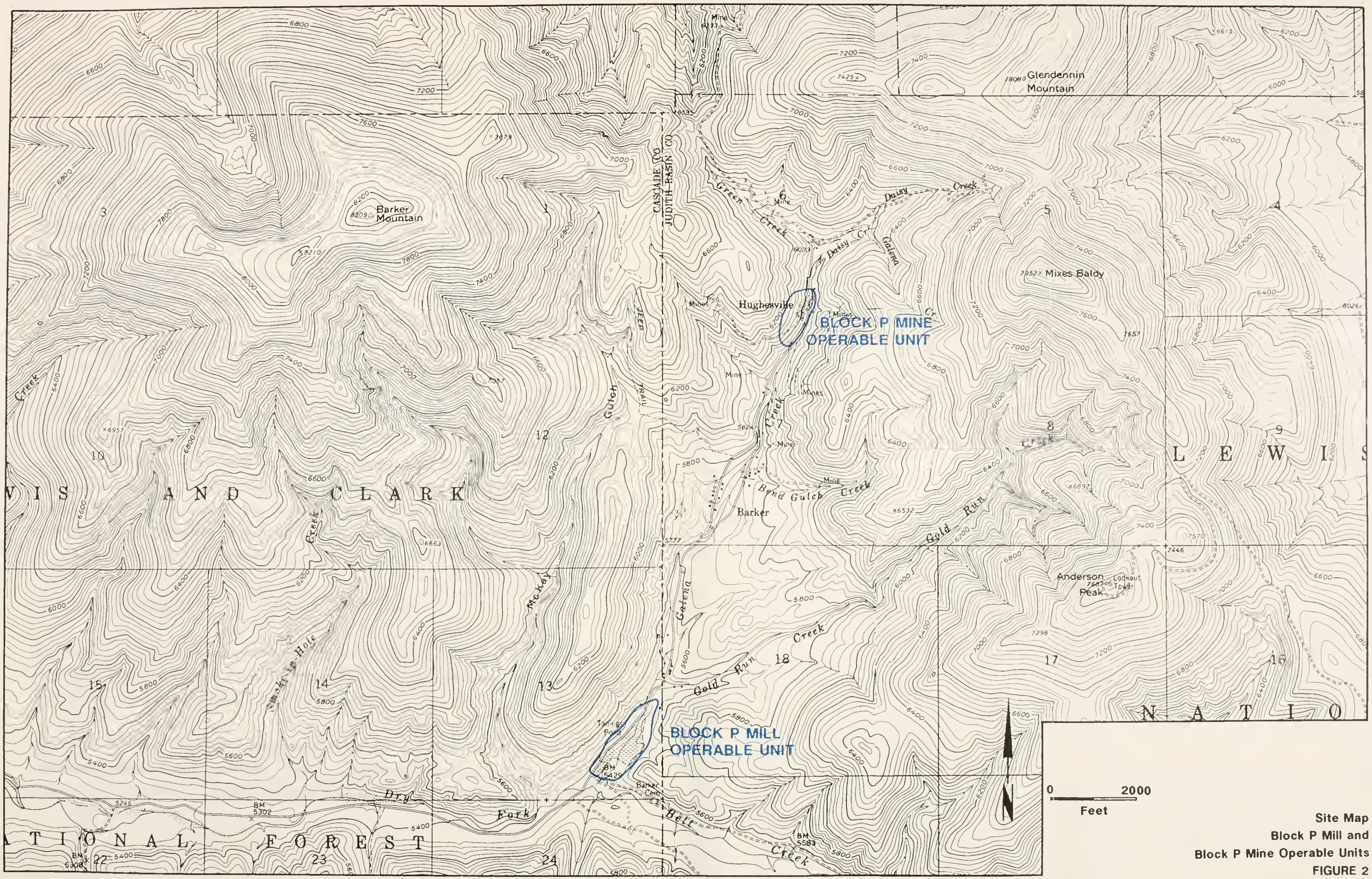
As stated previously, Chen-Northern completed a PA of the Hughesville/Barker Mining District during the fall of 1990. This effort was primarily directed toward collecting sufficient environmental information to identify OUs in the study area and prioritize those OUs relative to the timing of reclamation in the mining district.

1.3 GENERAL SITE CHARACTERISTICS

Galena Creek is located in a narrow valley bounded on both sides by relatively steep topography (Figure 2). Mine adits and shafts are located both along the valley bottom and along the adjacent hillsides. The historic towns of Barker and Hughesville are located along the valley bottom within the study area (Figure 2). The study area is primarily located on private land which includes both patented and unpatented mining claims. Most residents only reside in the area on a seasonal basis, typically during the summer months.

Galena Creek is a perennial stream with a relatively small drainage area. The stream is apparently sustained by groundwater inflow during low flow and baseflow conditions. Daily flows from August, 1973 to October, 1974 averaged approximately 2 cubic feet per second (cfs) at a station near the mouth of Galena Creek (DNRC, 1977). The stream is adversely impacted by mine wastes and acid mine discharge throughout most of its length. The creek changes color dramatically in the vicinity of the Block P Mine dump from clear to orange-brown. The stream remains off-colored beyond its confluence with the Dry Fork of Belt Creek.

Mine waste dumps and tailings are present throughout the study area. This material was derived from historic underground mining in the area and as a waste product from area mills. The largest mine waste dump is associated with the historic Block P Mine located near the head of Galena Creek. Two identified adit and/or shaft discharges in the vicinity of the Block P Mine dump appear to directly impact the quality of water in Galena Creek. Most of the ore extracted from the Block P Mine was processed at the Block P Mill located



Site Map
Block P Mill and
Block P Mine Operable Units
FIGURE 2

near the mouth of Galena Creek. Two relatively large tailing impoundments associated with this mill are still visible at this location.

1.4 OPERABLE UNIT DESCRIPTIONS

1.4.1 Block P Mill OU

The Block P Mill OU is located near the confluence of Galena Creek and the Dry Fork of Belt Creek (Figure 2). The OU consists of approximately 15 acres of abandoned mill tailings contained in two distinct impoundments (upper and lower). The tailings represent waste material derived through operation of a silver and lead mill from the early to mid-1900's. Most of the ore processed at the facility was derived from the Block P Mine and was transported via an aerial tramway to the mill site. The mill has been razed and only remnants of the foundation for the facility are currently visible at the site.

Several tens of thousands of cubic yards of tailings are present at the site. The tailings contain relatively high concentrations of metals (particularly copper, zinc, iron, cadmium, lead, and arsenic) as compared to off-site soils. These metals are readily solubilized in water and are therefore subject to transport via infiltration into the underlying groundwater system and with surface runoff. The lower tailings impoundment at the OU is located in the Galena Creek floodplain. Because of this, it is possible that flooding in Galena Creek could inundate the material and/or erode the material into the Dry Fork of Belt Creek.

1.4.2 Block P Mine OU

The Block P Mine OU is located near the headwaters of Galena Creek (Figure 2). This OU encompasses approximately 10 acres and includes the underground workings associated with the Block P Mine and the associated waste dump.

The Block P Mine was operated intermittently from the late 1800's to the mid 1900's to extract lead and silver ore. The mine consists of tens of miles of underground workings and is connected to the Wright and Edwards Mine located about one-half mile southwest of the

site. The primary access to the underground workings was through the Barker Shaft, located near the northern end of the OU (Figure 2).

The Block P Mine OU exerts a visible and measurable impact on the quality of water in Galena Creek which traverses the eastern edge of the OU (Figure 2). The mine dump associated with the OU contains several tens of thousands of cubic yards of material which contains relatively high concentrations of metals with respect to off-site soils. The dump is void of vegetation and is positioned on a steep slope. As such, the material is subject to mass wasting processes which deleteriously impact Galena Creek water quality.

The underground mine workings at the OU have flooded since the facility was abandoned. The groundwater level in the workings appears to vary seasonally; discharges from the underground into Galena Creek are visible during the spring at an adit positioned approximately 10 feet vertically above Galena Creek. A spring presumably connected to the underground workings is also visible in the Galena Creek streambed near the southern end of the OU. Data collected by DNRC (1977) indicate both these discharges contain high concentrations of metals.

Galena Creek becomes discolored in the reach of the stream adjacent to the Block P Mine OU. The color of the creek changes from clear above the OU to a rusty orange adjacent to and downstream from the OU. This color change is reflective of the input of metals-laden groundwater, presumably associated with the underground workings.

1.5 ELEMENTS OF THE FIELD SAMPLING PLAN

This field sampling plan (FSP) provides guidance for all field work to be completed in conjunction with Phase II activities at the Block P Mill OU and the Block P Mine OU. For each of the field activities, the FSP contains the following elements:

- Objectives

- Proposed sampling or data collection locations

- Sample or data designation and collection frequency

- Sampling or data collection equipment and procedures

- Sample handling and analyses (if applicable)

Field activities described in this FSP are designed to provide the data necessary to complete EE/CAs for the two OUs. Table 1 summarizes the field activities presented in this document, the general purpose for each activity, and the ultimate use of the collected data.

TABLE 1
SUMMARY OF FIELD ACTIVITIES
BLOCK P MINE AND MILL OUs PHASE II SITE INVESTIGATION

FIELD ACTIVITY	GENERAL PURPOSE	ULTIMATE DATA USE
Geotechnical Investigations	Determine geotechnical characteristics of various materials. Determine depths of contaminated materials.	Support calculations of loads, stabilities, and other physical characteristics of various material types.
Groundwater Investigation	Characterize the occurrence, quality, and hydraulic characteristics at key locations within the OUs.	Provide baseline information Provide data to evaluate reclamation alternatives using groundwater control or containment.
Field Mapping and Surveying	Determine the extent of contaminated materials. Identify potential borrow sources for various types of material. Determine measuring point elevations on monitoring wells. Determine elevations of stream channels in cross section.	Calculate volume of contaminated material. Evaluate feasibility of various reclamation alternatives. Determine direction of groundwater movement. Calculate stage of various design flood events.

2.0 GEOTECHNICAL INVESTIGATION

2.1 INTRODUCTION

Chen-Northern personnel will complete geotechnical investigations at both the Block P Mill OU and the Block P Mine OU. This section of the FSP describes the purpose for such investigations, the types of data to be obtained, and the methods to be utilized to obtain such data. The scope of the geotechnical investigations is based on the current level of knowledge of the OUs. It is recognized that the scope of work presented herein may be altered in response to information obtained during the course of the investigations.

2.1.1 Purpose

The purposes of the geotechnical investigations at the two OUs are to:

- Obtain geotechnical data to support analyses of capping, containment, removal, and other related reclamation alternatives during the EE/CAs to be completed for each OU.

- Obtain material thickness data to refine estimates of volumes of contaminated soils, tailings, and waste rock at each OU.

Geotechnical data collected at the Block P Mill OU will be obtained from locations which are areally distributed about both the upper and lower tailing ponds. We will focus the investigation at the Block P Mine OU on the head and the toe of the mine waste dump associated with the site. The steepness of the mine dump precludes data collection from the middle portions of the deposit without extensive physical modification of the waste dump.

2.1.2 <u>Scope of Work</u>

The geotechnical investigations at the Block P Mill and Block P Mine OUs will utilize a truck-mounted auger drill rig for the subsurface studies. Chen-Northern field engineers will direct the drilling effort to obtain the following types of information at key locations within each OU:

- Standard penetration tests at selected intervals.
- Borehole logs with visual material classification.
- Depth to groundwater (2-inch PVC piezometers will be installed where groundwater is encountered).
- Depth of auger refusal.

In conjunction with the drilling information obtained above, field personnel will obtain samples of materials encountered in the boreholes. Samples will be obtained from the drill cuttings and using both a split-spoon sampler and a shelby tube. Selected samples will be transported to our materials laboratory and analyzed for index properties and selected physical parameters. Typical physical properties that may be determined include:

- Index tests
  - Gradation (ASTM D422)
  - Atterberg limits (ASTM D4318)
  - Moisture content (ASTM D2216)
- Shear strength
- Density
- Specific gravity (ASTM C127-C128)
- Permeability (ASTM D2434)
- Moisture-density (ASTM D698; ASTM D1557)
- pH and resistivity
- Sulfate content

These data will be used to evaluate engineering feasibility aspects of several reclamation alternatives for the two OUs including removal, containment, and capping.

We will also ship selected samples collected during this drilling program to our analytical laboratory for determinations of total metal concentrations. These data generally will be used to determine the vertical extent of metals contamination in the subsurface, beneath the tailing deposits.

Access to the toe of the mine waste dump at the Block P Mine OU and parts of the Block P Mill OU will be constructed with earthmoving equipment. Drill pads will be constructed to accommodate the auger rig. If it is deemed necessary to develop access by crossing Galena Creek near the Block P Mine OU, all relevant regulations will be observed and necessary permits obtained.

2.1.3 Schedule

We anticipate the geotechnical investigation at the Block P Mill OU will take approximately four days to complete. The investigation at the Block P Mine OU will take from two to four days to complete. Additional time allowance will have to be made for access construction. We expect that the access construction can be completed during a two to four day period.

2.1.4 Data Quality Objectives

Data quality during the geotechnical investigations will primarily be dependent on the ability and experience of the field crew in obtaining viable field data and representative samples. Standardized ASTM procedures will be followed in collecting field data associated with this portion of the Phase II field investigation. By following such procedures, consistency with the standard-of-practice for collecting geotechnical information will be achieved. The level of accuracy associated with such techniques will be adequate for performing conceptual design evaluations during the EE/CAs for each OU.

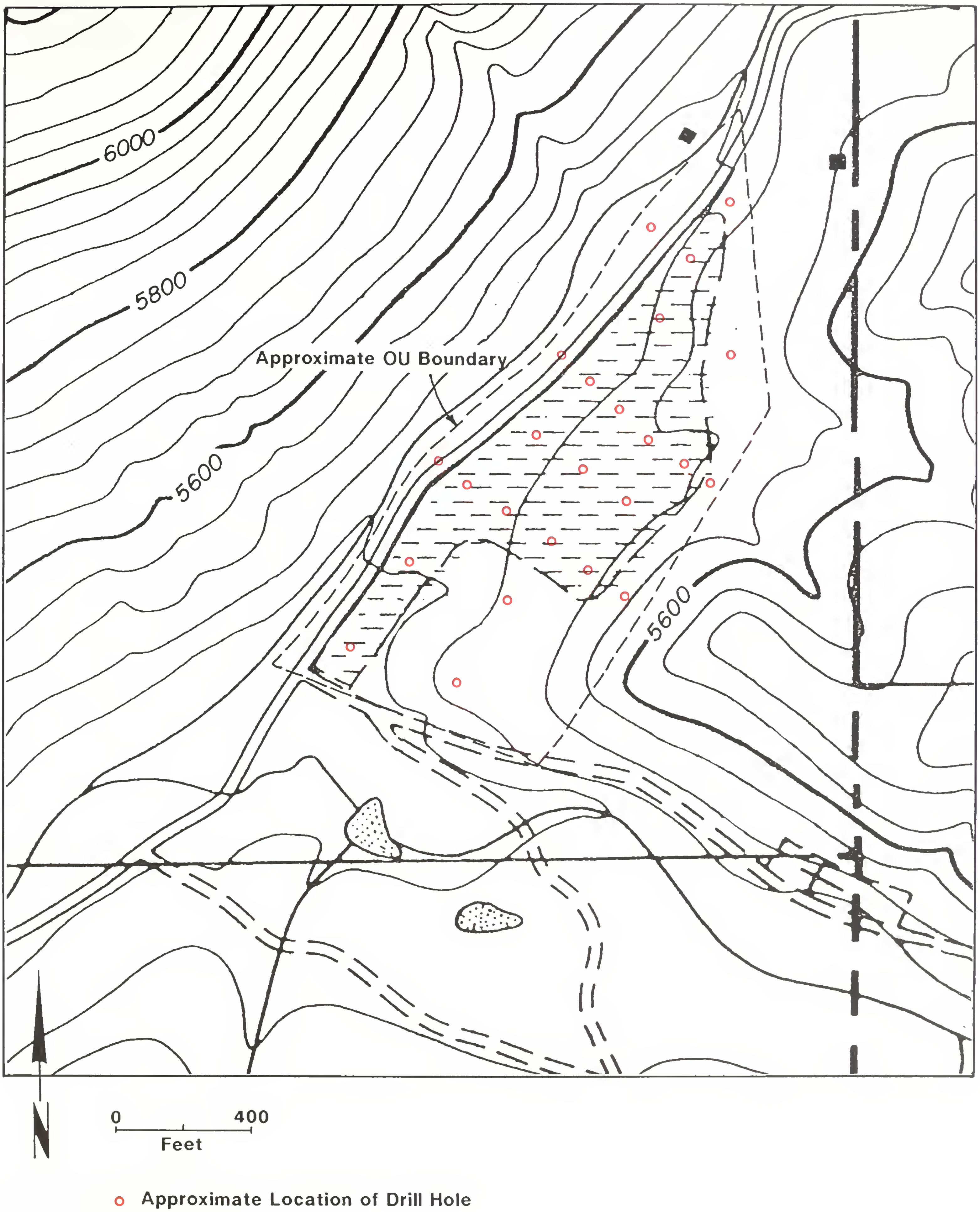
Material samples collected during the geotechnical investigations will be analyzed in the materials laboratory using standard ASTM procedures. Samples submitted for chemical laboratory analysis will be analyzed for parameters and detection limits listed in Appendix A of the QAPP (Chen-Northern, 1990a). Due to the inherent heterogeneous nature of soil and mine waste materials and given the accuracy and precision limitations of the analytical laboratory, the data resulting from this effort may show large variabilities. However, the degree of accuracy and precision obtained during this investigations should be sufficient to meet project objectives.

2.2 DRILLING AND SAMPLING LOCATIONS AND RATIONALE

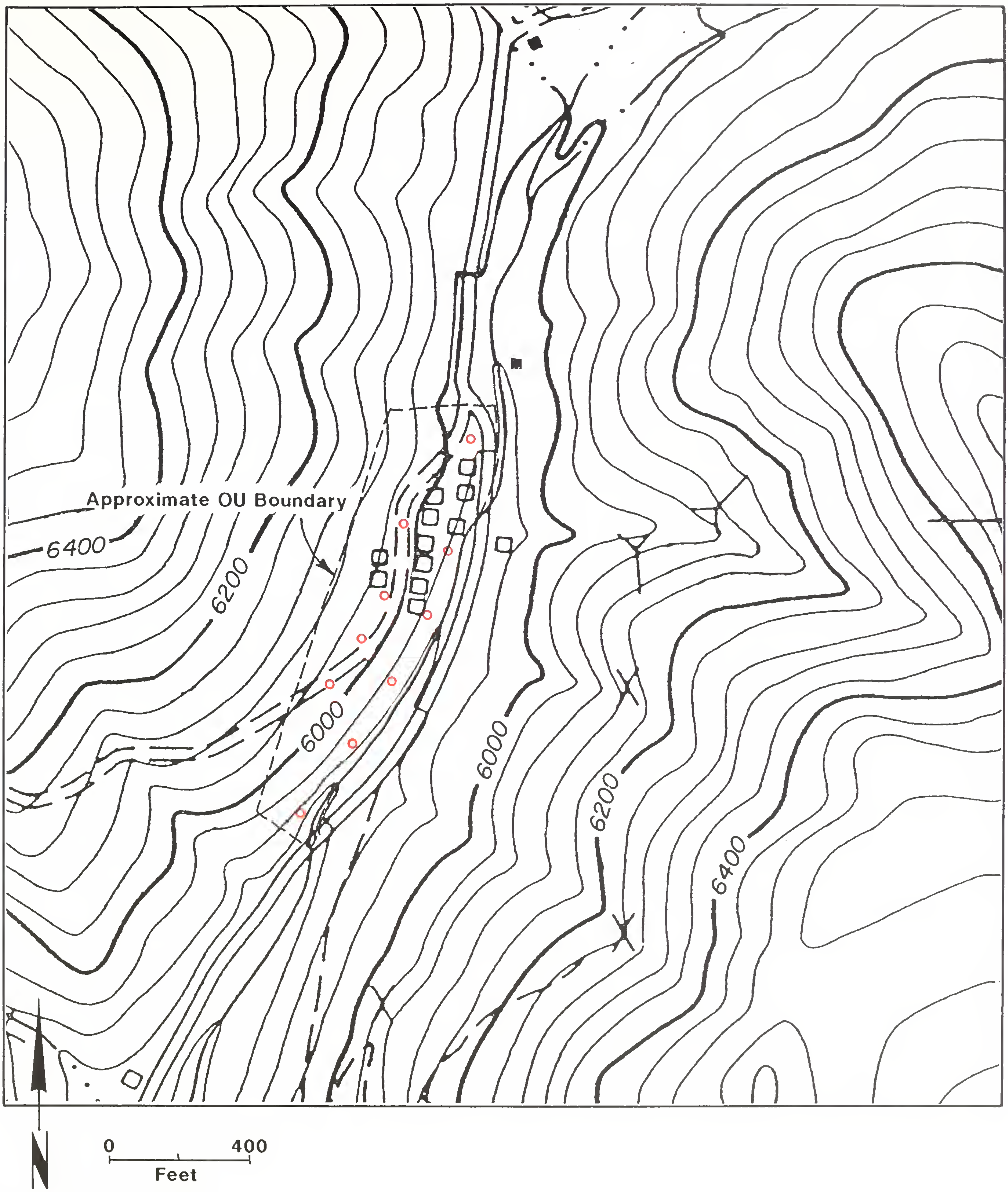
Figures 3 and 4 show proposed drill sites for geotechnical investigations at the Block P Mill OU and the Block P Mine OU, respectively. The drill hole locations at the Block P Mill OU (Figure 3) were selected to provide geotechnical data from a series of cross sections across the two tailing impoundments which generally encompass the entire OU. Such a distribution of drill hole locations will provide sufficient data to characterize general heterogeneities in the materials at the site.

Boreholes will be advanced to depths below the base of visible tailings and into native material. We project that total depths of most drill holes at the site will be approximately seven to 15 feet at the lower tailings area and 20 to 25 feet at the upper tailings area. We expect that we will experience auger refusal where bedrock is encountered, a situation that will likely occur at the upper tailings impoundment.

Proposed borehole locations at the Block P Mine OU (Figure 4) were selected to gather data from relatively accessible portions of the OU. Our intent is to gather geotechnical information from boreholes at the head and the toe of the Block P Mine waste rock dump. Data obtained from the top and bottom of the deposit will be extrapolated to the middle portion of the waste dump during engineering evaluations of various reclamation alternatives for the site.



Geotechnical Drill Hole Locations
Block P Mill Operable Unit
FIGURE 3



Approximate Location of Drill Hole

Geotechnical Drill Hole Locations
Block P Mine Operable Unit
FIGURE 4

The total depths of boreholes drilled at the top of the Block P Mine OU will probably be on the order of 35 to 50 feet. Boreholes at the base of the waste dump will likely be less than 10 feet deep. We anticipate that we will advance all boreholes until auger refusal is achieved in what we expect to be bedrock.

2.3 SAMPLE DESIGNATION AND FREQUENCY

Tailings, mine waste dump, and soil samples collected during the geotechnical investigations at the Block P Mill and Block P Mine OUs will be designated as [TYPE-xxx-yy.y-zz.z] according to the following scheme:

- (TYPE) -- Sample type designation: A letter code designation for sample type collected during the geotechnical investigations. Typical codes are:

    - SSS -- split spoon sample
    - STS -- shelby tube sample
    - SK -- sack sample

- (xxx) -- A unique three digit number beginning with 100 at the Block P Mill OU and beginning with 200 at the Block P Mine OU. Consecutive numbers shall be used at each OU from borehole to borehole.

- (yy.y and zz.z) -- Sample depth identifier: Two three-digit numbers indicating the depth interval (in feet and tenths of feet) from which the sample was obtained.

The frequency of sample collection will vary from borehole to borehole and will primarily be dependent upon the judgement of the field engineer accompanying the drill crew and the types of samples to be collected. Certain criteria should be considered when determining sampling and testing frequency at a borehole site:

- Standard penetration tests (SPTs) will be completed throughout the depth of the borehole.

- Samples will be collected from each unique lithologic unit encountered during borehole advancement.

A subset of the collected samples will be selected for submittal to the materials and chemical laboratories for subsequent analysis. Criteria for selecting such samples are presented in Section 2.5.

2.4 EQUIPMENT AND PROCEDURES

This section describes the methods and equipment we intend to use to complete the geotechnical investigations at the two OUs.

2.4.1 Testing and Sampling Equipment

A truck-mounted hollow-stem auger drill rig will be used to perform standard penetration tests (SPTs) and collect most material samples during the geotechnical investigations. The auger rig will be equipped with standard 8-inch flight auger and a 4-inch pilot bit.

2.4.2 Field Testing and Sampling Methodology

Field crews will maintain field notebooks throughout the duration of the geotechnical investigations. The field notebooks will be weather-resistant, bound, survey-type books with non-removable pages. Any comments or other notes will be entered directly into the field notebook using permanent, indelible ink. Errors will be lined through and corrected with a new entry. A summary of activities will also be entered into the field book at the end of each field day.

Standard borehole logs will be used to log lithologic, geotechnical, and hydrogeologic information at each drill site. All field observations, material descriptions, and hydrogeologic information will be recorded on these field forms. An example of the type of field form to be used during this investigation is shown in Figure 5. All downhole testing and sampling equipment will be decontaminated prior to collection of samples for laboratory analysis of total metals using procedures described in Section 2.4.3, below.

Standard penetration tests will be performed in accordance with ASTM D-1586. If possible, split-spoon and shelby-tube samples will be collected from each unique lithologic unit encountered in each borehole. These samples will be collected in advance of the pilot bit. Samples from the split-spoon will be placed in sample bags on-site for subsequent transport. Shelby tube samples will be maintained in the sampler and transported to the materials laboratory for analysis.

2.4.3 Equipment Decontamination

All downhole equipment associated with the auger drill rig will be decontaminated using Chen-Northern's portable steam cleaner. Following steam cleaning, the equipment will be rinsed with dilute nitric acid and deionized water. Split-spoon samplers will be decontaminated before each use when collecting samples for chemical analysis.

2.4.4 QA/QC Samples

QA/QC samples will be inserted into the train of samples destined for laboratory chemical analysis at a minimum frequency of 5% of the samples submitted. These samples will be submitted to the laboratory blind and will include duplicate samples and blind field standards. At least two sets of these samples will be submitted with every sample lot. Methods and necessary paperwork to complete QA/QC sampling are described in SOP-13 (Appendix A).

Matrix spikes and will be prepared by the laboratory for samples to be analyzed for chemical constituents at a minimum frequency of 5% of the samples analyzed. Further

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LOG OF EXPLORATION BORING

PROJECT:

JOB NO.:
DRILL TYPE: SOIL
ROCK
DRILLED BY:
LOGGED BY:
REMARKS:

HOLE NO.
SHEET OF
LOCATION:

ELEVATION: TOP OF HOLE
GROUNDWATER
DATE: HOLE STARTED
COMPLETED

DEPTH (Feet)	LEGEND	CLASSIFICATION AND DESCRIPTION	SAMPLE SYMBOL	S.P.T. (N) (BLOWS/FT.)	MOISTURE CONTENT (%)	IN-PLACE DRY DENSITY (pcf)	L.L. %	P.I. %	GRAVEL %	SAND %	SILT %	CLAY %

Example of Geotechnical Drill Log
FIGURE 5

details regarding laboratory analytical protocol with respect to QA/QC requirements for the project are contained in the project QAPP (Chen-Northern, 1990a).

2.5 SAMPLE SELECTION, HANDLING, AND ANALYSIS

Table 2 summarizes the expected numbers and types of samples to be collected, preservation needs, necessary sample containers, and shipping requirements for the various samples collected during the geotechnical investigations.

All samples collected will be transported in coolers via truck to either Chen-Northern's analytical laboratory in Billings or our materials laboratory in Helena. Advance notice of the shipment date will be given to the laboratory.

Criteria to be used for selecting which samples will be analyzed for the various physical and chemical tests include the following:

- Index tests (gradation, Atterberg limits, moisture content) -- Samples for index testing will be selected based on visual field classifications to delineate horizontal and vertical distribution of physical material properties.

- Other physical tests -- Samples for other physical tests will be selected based on visual field classification and will be limited to materials for which the resultant data are necessary to complete reclamation evaluations.

- Total metals/pH/SC -- Samples selected for these analyses will generally include representative material types (based on visual examination) obtained from vertical intervals beneath the base of mill tailings or waste rock material.

TABLE 2
SAMPLES, ANALYSES, PACKAGING, AND SHIPPING REQUIREMENTS
Geotechnical Investigation
Block P Mill and Block P Mine Operable Units

ANALYSIS[1]	EST. # OF NATURAL SAMPLES[3]		ASSUMED CONCENTRATION	CONTAINER TYPE	PRESERVATION METHOD	HOLDING TIME
	BLOCK P MILL OU	BLOCK P MINE OU				
Total Metals/pH/SC	15	10	Medium	2-gallon resealable polyethylene bag	None	None
Index Tests[2]	20	5	N/A	2-gallon resealable polyethylene bag and canvas sack	None	None
Shear Strength	2	1	N/A	Canvas sack or shelby tube	None	None
Density	1	1	N/A	Shelby tube	None	None
Specific Gravity	2	0	N/A	Canvas sack or shelby tube	None	None
Permeability	3	0	N/A	Canvas sack or shelby tube	None	None
Moisture-density	3	1	N/A	Canvas sack	None	None
Resistivity	3	2	N/A	2-gallon resealable polyethylene bag	None	None
Sulfate content Conductivity	3	2	N/A	2-gallon resealable polyethylene bag	None	None

Notes:

1: Analytical methods and detection limits for chemical analyses contained in project QAPP (Chen-Northern, 1990a)
2: Includes gradation (ASTM D422), Atterberg limits (ASTM D4318), and moisture content (ASTM D2216).
3: QA/QC samples submitted with each sample set shipped to analytical laboratory for chemical analysis will include 2 duplicate samples and 2 cross-contamination blanks.

3.0 GROUNDWATER INVESTIGATION

3.1 INTRODUCTION

A groundwater investigation will be completed in conjunction with Phase II field data collection activities at the Block P Mill and Block P Mine OUs. The components of this investigation will include installation of monitoring wells, groundwater sampling, aquifer testing, and water level measurement.

3.1.1 Purpose

The primary objective of completing a Phase II groundwater investigation is to determine groundwater characteristics of key water-bearing zones at selected locations in both OUs. Monitoring wells will be installed along the eastern side of the Block P Mill OU to determine groundwater characteristics of the hydrogeologic system (including springs) entering the OU from the east. In addition, monitoring wells will be installed along the southern and western boundaries of the OU. Data from these locations are necessary to evaluate various reclamation alternatives pertaining to groundwater control and containment and the no-action alternative.

Monitoring wells will be installed at key sites at the Block P Mine OU in an attempt to characterize the impact of the underground mine workings on Galena Creek. This information is desirable to evaluate reclamation alternatives which are oriented toward controlling and/or treating acid mine drainage in this OU.

3.1.2 Scope of Work

To achieve the objectives described above, the scope of work includes:

- Drilling and installing seven to 10 monitoring wells with estimated depths ranging from 20 to 80 feet.

- Developing all wells until the discharge water is relatively free of turbidity, sand, and drilling fluids.

- Sampling certain monitoring wells for analysis of inorganic parameters.

- Testing certain monitoring wells to determine hydraulic characteristics of various water-bearing units.

- Measuring water levels in monitoring wells to determine directions of groundwater movement at various locations.

3.1.3 Schedule

We anticipate that field investigations associated with the groundwater studies at the two OUs will take one to two weeks to complete. Laboratory analyses will require approximately four to six weeks to complete. Inclement weather may delay completion of field investigations.

3.1.4 Data Quality Objectives

Data obtained during the groundwater investigations will be used to evaluate the chemical and hydraulic characteristics of certain groundwater systems within the two OUs. Lithologic information obtained during drilling will be used to evaluate hydrogeologic conditions with respect to flow paths and contaminant sources.

Types of data to be obtained during the groundwater investigations include site-specific lithology, groundwater contaminant concentrations, general groundwater quality parameters, hydraulic head, and hydraulic conductivity.

It is necessary to collect data of sufficient quality and quantity to evaluate several reclamation alternatives which include groundwater control, diversion, and treatment and tailings capping alternatives. The quality of the field observations and field tests completed

during the study will, in a large part, be dependent upon the experience and training of the field personnel associated with the project. We intend to staff this project with qualified personnel who are experienced in all aspects of the scope of work associated with this project. Senior groundwater professionals will review all project work to insure accurate and defensible data are acquired.

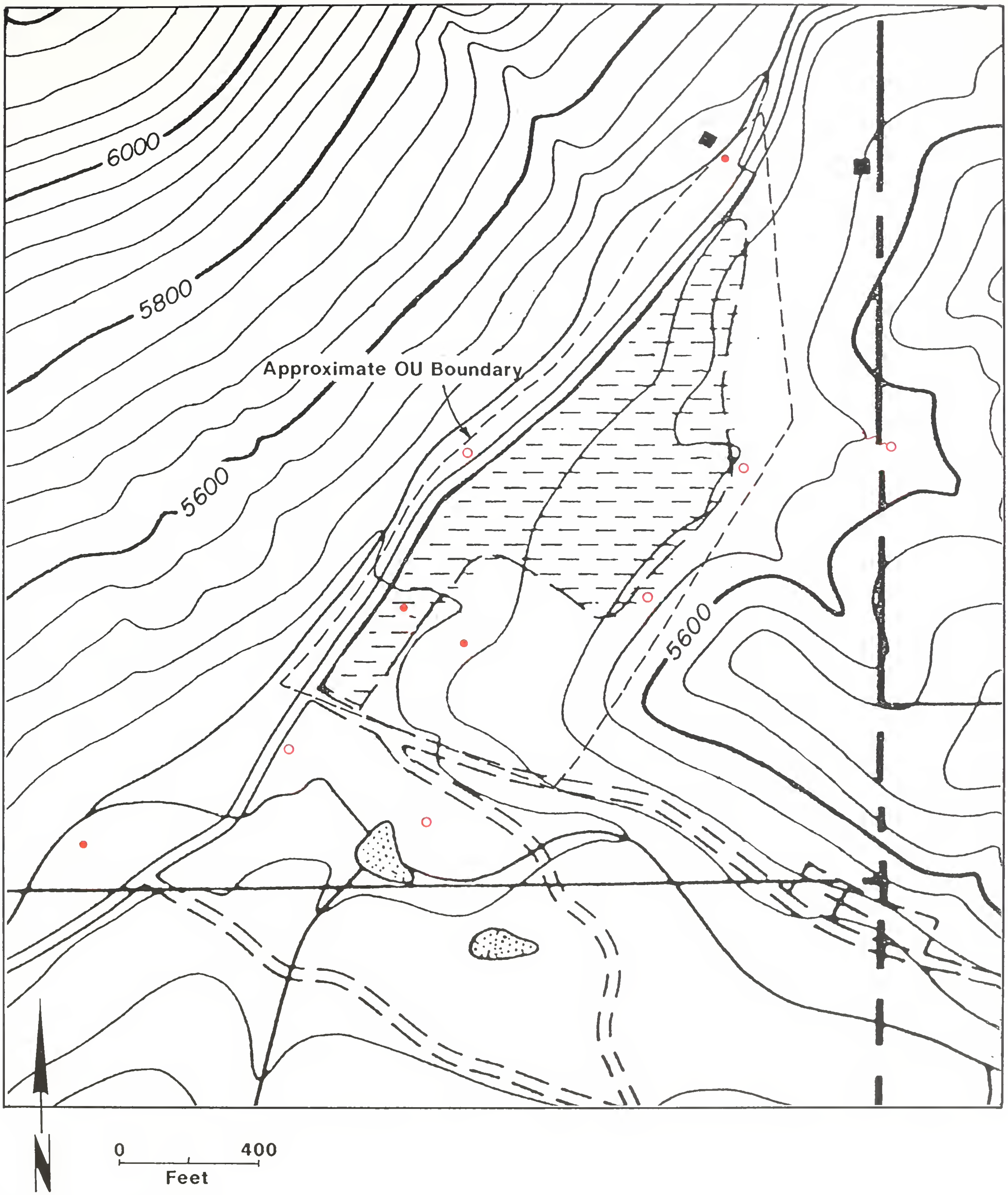
The quality of laboratory analyses resulting from the groundwater investigation will be evaluated through our data validation process. This process involves quantifying the quality of the data with respect to precision, accuracy, and representativeness. Such checks will allow us to insure that the quality of analytical data produced during this study are sufficient to meet project objectives.

3.2 WELL INSTALLATION

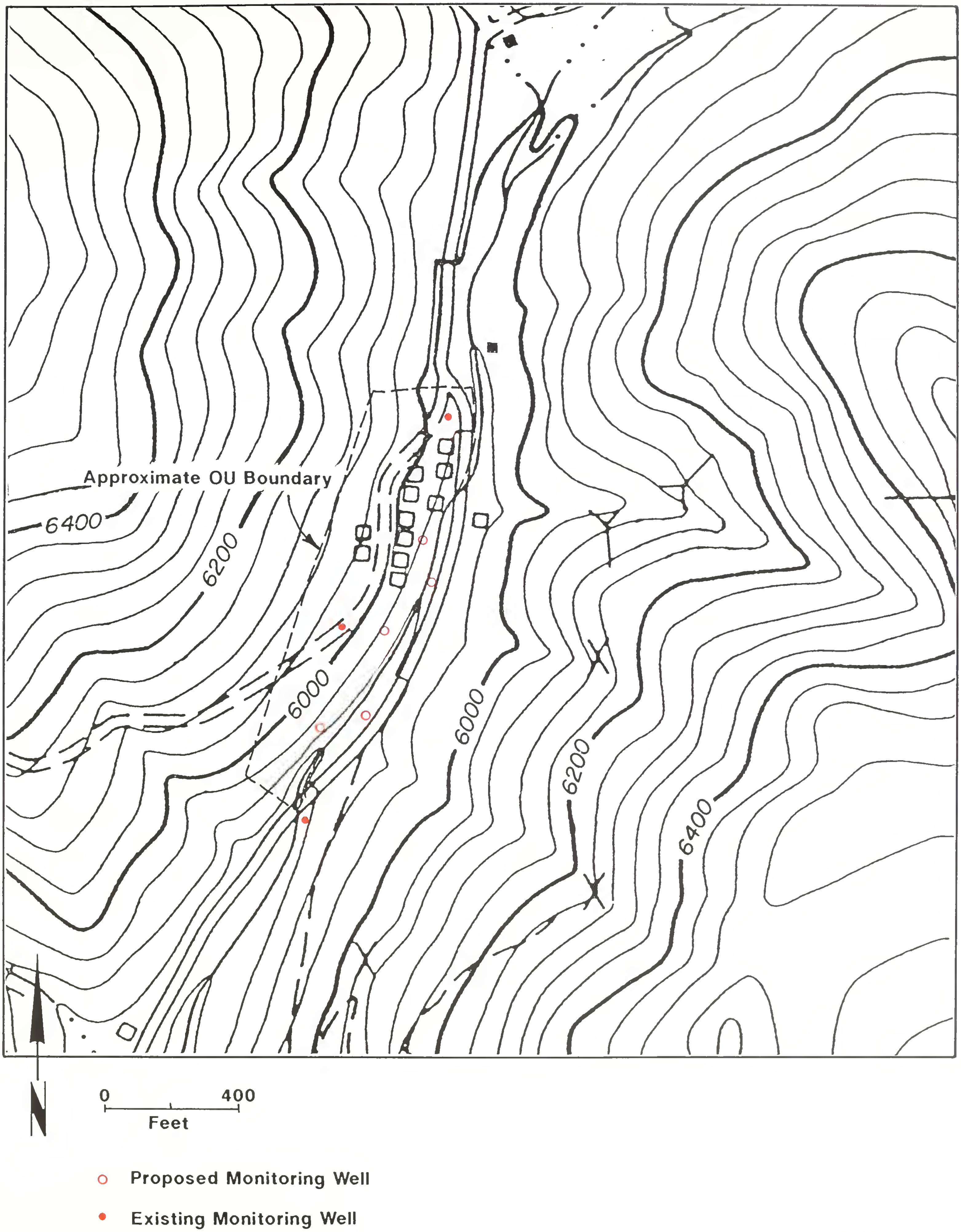
3.2.1 Locations and Siting Rationale

Monitoring wells will be installed in the area along the western, eastern and southern edges of the Block P Mill OU (Figure 6). The purpose of installing these wells is to characterize groundwater systems entering the OU from the east and exiting the OU to the south and west. It is suspected that a groundwater system enters the OU from the east and becomes contaminated as it moves through the tailing impoundments. Data are needed to characterize this system such that reclamation alternatives which isolate this component of groundwater flow from the deposit can be evaluated during the EE/CA. Wells are necessary south and west of the OU to provide a means of directly measuring the impact of the groundwater system on Galena Creek and the Dry Fork of Belt Creek. The monitoring well locations depicted on Figure 6 may be adjusted in the field depending upon site access constraints.

Monitoring wells will be installed at several locations along the base of mine dump at the Block P Mine OU (Figure 7). Wells along the west side of Galena Creek at this OU will be installed at drill pads constructed for the geotechnical investigation (see Section 2.2). Wells installed along the east side of Galena Creek will be located along the east side of



Monitoring Well Location Map
Block P Mill Operable Unit
FIGURE 6



Monitoring Well Location
Block P Mine Operable Unit
FIGURE 7

the road through the area. The purpose of these wells is to provide a means to quantify the quality and rate of groundwater input to Galena Creek in this reach. This information is necessary to evaluate reclamation alternatives that utilize groundwater control or diversion and treatment.

3.2.2 Well Designation

Monitoring wells installed during the Phase II investigation will be designated HMW-9 through HMW-18 (Figures 6 and 7). This numbering sequence is consistent with and is a continuation of that system used for numbering monitoring wells during the preliminary assessment of the mining district.

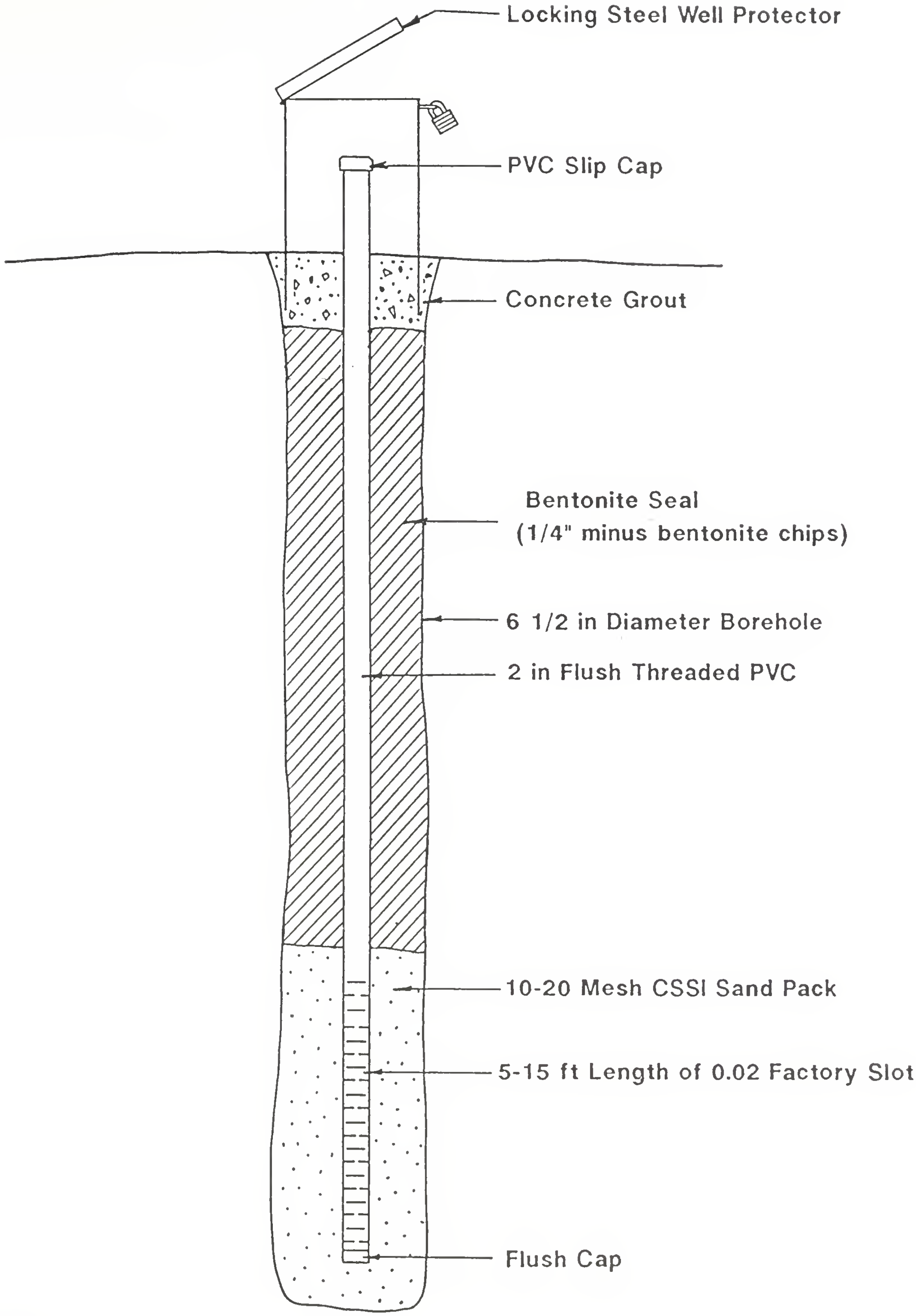
3.2.3 Drilling Equipment and Well Installation Procedures

Boreholes which will host the monitoring wells will be drilled from the ground surface to the total depth using air rotary drilling techniques in accordance with SOP-16 (Appendix A). Decontamination of down-hole drilling apparatuses will be completed in accordance with SOP-11 (Appendix A).

The general monitoring well design is illustrated on Figure 8. Well casing will consist of 2-inch or 4-inch I.D. Schedule 40 PVC. The casing will be flush threaded and PVC casing centralizers will be installed as necessary. The well screen to be used in the installation will be a factory-produced section with a slot size of 0.02 inches.

Clean silica sand will be used to pack the annulus of the screened interval. The sand will be composed of inert non-carbonate material, well rounded and graded to match the aquifer and slot size. The amount of sand to be used in each well will be calculated from the volume of the annulus to be filled. The sand pack will be extended two feet above the top of the well screen.

A two-foot bentonite seal will be placed on top of the sand pack. The remaining well annulus will be filled with bentonite chips. The monitoring wells will be enclosed in a



Monitoring Well Schematic
FIGURE 8

protective steel pipe with a locking cap. The protective surface casing will be set in a concrete pad which slopes away from the well casing.

Field crews will maintain field notebooks throughout the duration of the well installation effort. The field notebooks will be weather-resistant, bound, survey-type books with non-removable pages. Any comments or other notes will be entered directly into the field notebook using permanent, indelible ink. Errors will be lined through and corrected with a new entry. A summary of activities will also be entered into the field book at the end of each field day.

All data generated during the well installation task will be entered on forms designed for this application. Figure 9 is an example of a form which is suitable for this purpose. Important information to be included on this form includes lithologies, water production information, and field parameter data for water encountered during drilling.

Samples of lithologies encountered in each borehole will be collected and bagged. Material samples will be collected from each 5-foot interval or at significant changes in lithology. These samples will be archived for future use.

3.2.4 Well Development

Wells installed during this investigation will be developed using a bailer and/or surge block. Development will continue until water being removed is relatively clear and free of sand. The parameters of pH, specific conductivity, and temperature will be monitored during well development. At least three consecutive measurements of these parameters will be within ±5% of each other before well development will be considered complete.

3.2.5 Decontamination Procedures

All down-hole drilling equipment, monitoring well materials, and well development equipment will be decontaminated using a portable decontamination trailer. Decontamination will be completed following completion of each monitoring well in accordance with SOP-11 (Appendix A).

MONITORING WELL LITHOLOGIC AND COMPLETION LOG

JOB NO.: ________________

PROJECT: ____________________ STATE: _____ COUNTY: ______________ WELL NO.: ____________

LEGAL LOCATION: T____ R____ S____ TRACT______ DESCRIPTIVE LOCATION: ______________________

DATE STARTED: ______ DATE COMPLETED: ______ DRILLING COMPANY/ DRILLER: __________________ LOGGED BY: ____________

DRILLING METHOD: ______________ BOREHOLE DIAMETER (In): ________ DRILL FLUIDS USED: ______________

TOTAL DEPTH DRILLED (ft): ____ TOTAL DEPTH CASED (ft): ____ INTERVAL PERFORATED OR SCREENED (ft): from: _____ to: _____ DIAMETER AND TYPE OF CASING: ______________

METHOD OF PERFORATION:
___ Open Hole
___ Open Bottom
___ Saw Slotted
___ Factory ______________ (size)
___ OTHER (specify) ______________

DURING WELL CONSTRUCTION WAS/WERE:

	YES	NO
WELL DEVELOPED	___	___
WELL PUMPED	___	___
WATER SAMPLES COLLECTED	___	___
MATERIAL SAMPLES COLLECTED	___	___

ANNULAR COMPLETION CHARACTERISTICS
WELL PROTECTOR: Length _____ Diam. _____
LOCK NO.: ______________

SURFACE SEAL: Type: ________ from: ________ to: ________
BACKFILL: Material: ________ from: ________ to: ________
FILTER PACK: Type: ________ from: ________ to: ________

STATIC WATER LEVEL: ________ MEASURING POINT DATE: ________ DESCRIPTION/ ELEVATION: ______________ MEASURING POINT RELATIVE TO GROUND SURFACE (+/-): ________

REMARKS: ____

INTERVAL (FT) below ground surface	LITHOLOGIC DESCRIPTION	REMARKS

Example of Monitoring Well Log

FIGURE 9

3.3 GROUNDWATER SAMPLING

3.3.1 Sample Locations

Groundwater samples will be collected from all monitoring wells installed during this investigation and from two existing monitoring wells at each OU. (Figures 6 and 7). In addition, the spring located above the upper tailings pond at the Block P Mill OU (Figure 6) will be sampled.

3.3.2 Sample Designation and Frequency

Groundwater samples collected from monitoring wells will be identified according to the monitoring well designation (e.g. HMW-1). Blind duplicate samples will be designated with the number of a non-existent well (e.g. HMW-21). Blind field standards will be designated in a similar manner using a higher series of numbers (e.g. HMW-31).

The date and time of sampling will be recorded on the sample label along with the well designation. Any preservative used will also be noted along with the initials of field personnel.

Groundwater samples will be collected a minimum of one time during this investigation. Static water level measurements will be obtained prior to collection of groundwater samples. Any additional measurements will be made as deemed necessary by the Project Manager.

3.3.3 Sampling Equipment and Procedures

Field crews will maintain field notebooks throughout the round of sampling and static water level measurement. The field notebooks will be weather-resistant, bound, survey-type books with non-removable pages. Any comments or other notes will be entered directly into the field notebook using permanent, indelible ink. Errors will be lined through and corrected with a new entry. A summary of activities will also be entered into the field book at the end of each field day.

Prior to sampling, the depths to water will be measured to the nearest 0.01 foot and recorded in the field notebook. Static water levels will be measured with a decontaminated electric well probe or its equivalent. During sampling, all the activities will be recorded on a groundwater sampling log. An example of this log is presented in Figure 10.

Well evacuation will be performed in accordance with SOP-18 (Appendix A). The pH, specific conductivity, and temperature of the groundwater will be measured at least three times during well evacuation and recorded in the field notebook. Field parameter measurements will be within ±5% on three consecutive readings before evacuation is considered complete.

Groundwater samples will be collected using a decontaminated PVC bailer. Caution will be exercised in transferring samples from the bailer to the sample containers so that air entrainment in the sample is minimized. Groundwater samples will be collected in one liter plastic bottles in accordance with specifics contained in Table 3.

3.3.4 QA/QC Samples

QA/QC samples will be inserted into the sample train at a minimum frequency of 5%of the total number of wells sampled. These samples will be submitted to the laboratory blind and will include duplicate samples, cross-contamination blanks, and blind field standards. At least two sets of these samples will be submitted with every sample lot. Methods and necessary paperwork to complete QA/QC sampling are described in SOP-13 (Appendix A).

3.3.5 Sample Handling and Analysis

The scheduled analyses for groundwater samples is contained in the project QAPP (Appendix A). A summary of analyses is contained in Table 3. All samples will be analyzed for metals, major anions, cations, total dissolved solids, pH, and specific conductance. Analyses of metals will include those for dissolved fractions for the following: aluminum, arsenic, cadmium, copper, chromium, iron, lead, manganese, nickel, and zinc.

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GROUNDWATER SAMPLING AND MEASUREMENT

Project: ____________________ Date/Time: ____________
Sta. No. ________ T ______ R ______, Sec ______, Tract ______
Narrative Description ____________________
Personnel ____________________
Weather ____________________
Type of well __________ TD __________ SWL __________
Casing __________ Inside Diameter __________ Log: Y N
Casing Stickup ____________________ Well Locked: Y N
Aquifer ____________________
Measuring Point Description ____________________

Meter	Serial No	Calibrated	Meter	Serial No	Calibrated
pH			Eh		
SC			DO		
Thermo			M-Scope		

Depth to Static Water/Continuous Recorder Data

______ ft __________ Hours DSM Reading __________
______ ft __________ Hours DSM Reading __________
______ ft __________ Hours DSM Reading __________
Chart or Chip Removed: Y N Replaced: Y N

Well Evacuation

Bore volume: $1/25 \times (TD-SWL) \times (dia)^2 =$ __________ gallons
Well Evacuation Method ____________________
Remarks ____________________

Evacuation Data

SC	pH	DO	Time	Gallons	Rated

STA. No. __________
Well Sampling Method ____________________
Decontamination Code (See page 1 of booklet) A B

Specific Conductance Temperature Correction Table

Temp	Factor	Temp	Factor	Temp	Factor	Temp	Factor
-1	1.89	8	1.46	17	1.18	26	0.98
0	1.84	9	1.42	18	1.15	27	0.96
1	1.79	10	1.38	19	1.13	28	0.94
2	1.74	11	1.35	20	1.10	29	0.92
3	1.68	12	1.32	21	1.08	30	0.90
4	1.63	13	1.29	22	1.06	31	0.88
5	1.58	14	1.26	23	1.04	32	0.86
6	1.54	15	1.23	24	1.02		
7	1.50	16	1.20	25	1.00		

Sample Data

Water Temp. (1)	Observed SC (umhos) (2)	Temp. Correction Factor (3)	Call Factor Above (7)	Sample SC=(2)x(3)x(7) (umhos/cm @ 25°c)

FIELD DATA

Water Temperature __________ (°C) SC __________ (umhos/cm @ 25°C)
Diss. Oxgyen __________ (mg/L) pH __________ (Standard Liters)
S.W.L. __________ (ft) Eh __________ (millivolts)
Water Quality Samples: Y N Chain-of-custody: Y N

Bottle	Parameters	Preservative

Lab ____________________ Analysis Request Form: Y N
Desc of Water: Start __________ Finish __________

Example of Groundwater Sampling Form
FIGURE 10

TABLE 3
SAMPLES, ANALYSES, PACKAGING, AND SHIPPING REQUIREMENTS
Groundwater Investigation
Block P Mill and Block P Mine Operable Units

ANALYSIS[1]	EST. # OF NATURAL SAMPLES[2]		ASSUMED CONCENTRATION	CONTAINER TYPE	PRESERVATION METHOD	HOLDING TIME
	BLOCK P MILL OU	BLOCK P MINE OU				
Dissolved Metals	4	6	Medium	One liter polyethylene bottle; fill approximately one-quarter full	Filter on-site; HNO_3 to pH < 2	6 months
Common Ions	4	6	Low	One liter polyethylene bottle; fill to shoulder	Cool to 4°C	14 days
Nitrate + Nitrite	4	6	Low	One liter polyethylene bottle; fill to shoulder	H_2SO_4 to pH < 2	28 days

Notes:

1: Analytical methods and detection limits for chemical analyses contained in project QAPP (Chen-Northern, 1990a)
2: QA/QC samples submitted with each sample set shipped to analytical laboratory will include 2 duplicate samples, 2 blind field standards, and 2 cross-contamination blanks.

Appendix A of the QAPP lists method detection limits and laboratory methods to be used for the analyses listed above.

3.4 AQUIFER TESTING

Slug tests will be completed in conjunction with the groundwater investigation at the Block P Mill and Block P Mine OUs. In addition, a short-term aquifer pumping test will be completed at the Block P Mill OU. Based on information obtained during the preliminary assessment at the site, it is expected that slug testing will provide most of the necessary hydraulics information for completing an EE/CA for each OU. Slug tests involve inserting or extracting a cylindrical apparatus into a monitoring well. The response of the water-bearing unit to a sudden increase or decrease in water level is measured. These data are then used to quantify the hydraulic conductivity of the monitored zone. Such information is necessary to calculate groundwater flux.

A constant discharge pumping test will be completed at one of the monitoring wells located south of the Block P Mill OU. Such a test is necessary because PA data indicate the groundwater system in this area is too prolific to gain usable data by slug testing techniques.

3.4.1 Test Locations

Slug tests will be performed in all monitoring wells installed as part of this investigation (Figures 6 and 7). The pumping test will be completed in well HMW-2 (Figure 6).

3.4.2 Test Equipment and Procedures

Field equipment required for slug testing consists of a solid cylindrical slug and a pressure transducer with a data recorder. Slug tests will be performed in accordance with SOP-26 (Appendix A). The pumping test will be performed for approximately 6 to 8 hours in accordance with SOP-26 (Appendix A). Near-by monitoring wells will be used as observation wells during the course of the test.

Hydraulic pressure and time data from the slug and pumping tests will be transferred from the data logger directly to a microcomputer. Hydraulic pressure data will be plotted against time to show time-recovery and time-drawdown relationships. Slug test data will be evaluated using methods described in Lohman (1972) and Bouwer and Rice (1976). Pumping test data will be evaluated using methods described in Lohman (1972).

3.5 WATER LEVEL MEASUREMENT

Water level data will be obtained from the monitoring well network at each OU. These data will be used to calculate groundwater gradients and determine directions of groundwater movement at the two sites.

3.5.1 Well Locations

Water levels will be measured in all monitoring wells at each OU. These wells will include those installed during this investigation and those previously installed during the preliminary assessment (Figures 6 and 7).

3.5.2 Equipment and Procedures

Water levels will be measured with and electric well probe in accordance with SOP-20 (Appendix A). Measurements will be made from designated measuring points on each well prior to sampling or slug testing.

4.0 FIELD MAPPING AND SURVEYING

4.1 INTRODUCTION

Field mapping and surveying work tasks will be completed in conjunction with the Phase II site investigation at the two OUs to provide necessary information to complete EE/CAs. These types of data are needed to evaluate reclamation alternatives that include removal, containment, diversion, and capping.

4.1.1 Purpose

The purposes for completing field mapping and surveying work tasks are to:

- Determine the lateral extent of metals-enriched areas within the two OUs.
- Determine the cross-sectional configuration of tailings and waste rock dumps at the OUs.
- Provide survey data with which the impacts of flood flows in Galena Creek on the OUs can be evaluated.
- Identify sources of various types of borrow material in the vicinity of the OUs.

Data collected during this effort to determine the extent of metals-enriched areas will be used in conjunction with data collected during the geotechnical investigations to refine volume and area estimates of waste rock and tailings material at the sites. These data are necessary to evaluate reclamation alternatives involving removal, containment, and consolidation.

This portion of the Phase II investigation will also include collection of a limited number of material samples for laboratory analysis. These data are necessary to determine if metals

have migrated into underlying and adjacent native soils. Such information is necessary to evaluate volumes of materials to be reclaimed at each site.

Survey data will also be used to evaluate the impact of various design flood flows in Galena Creek on the OUs. Surveyed sections across the stream will be compared to stages of peak flood flows for various design flood flows to evaluate the potential for erosion and sedimentation from the OUs into Galena Creek and the Dry Fork of Belt Creek.

Sources of various types of borrow material for capping and containment reclamation alternatives will also be identified under this portion of the investigation. This type of information is necessary to evaluate cost components during the EE/CAs for the two OUs.

4.1.2 Scope of Work

The scope of work associated with this portion of the investigation will include the following:

- Field mapping -- The extent of visible tailings and mine waste materials will be identified on a topographic base map of the OUs. Such mapping will be completed in the field by a qualified scientist.

- Material sampling -- A limited number of soil, tailings, and mine waste samples will be collected in conjunction with the field mapping effort. These samples will be collected from key locations at each OU to provide data with which the degree of metals enrichment in materials adjacent and subjacent to visible mine waste materials can be evaluated. Such information is necessary to refine volume estimates at the OUs.

- Surveying -- A surveyor and rodperson will survey several cross-sections at each OU. Such data will be used in conjunction with drilling information and laboratory data to determine the volume of metals-enriched material at each OU. In addition, cross-sections of Galena Creek adjacent to the OUs will be surveyed. These data will be used to determine elevations of stream stage during various flood flows in Galena Creek.

- Borrow Material Identification -- Sources of various types of borrow material (e.g. topsoil, riprap, gravel) will be identified. As a precursor to field verification of these sources, we will review the available literature to determine if any commercial or undeveloped borrow sources are located within a reasonable distance of the OUs. Verification or investigation of such sources will primarily involve field visits and collection of a limited number of samples of the materials for gradation analysis.

4.1.3 Schedule

Field activities associated with the field mapping and surveying work tasks will take less than one week to complete. Laboratory analyses performed on samples collected during this effort will require approximately four to six weeks to complete.

4.1.4 Data Quality Objectives

Data produced as a result of completion of the field mapping and surveying tasks will be used to evaluate the volume of material contaminated by metals at each OU. In addition, survey data from cross-sections of Galena Creek will be used to evaluate the impact of various design flood flows on each OU.

Data quality resulting from this portion of the investigation will primarily be dependent on the experience of field personnel and use of proper mapping, surveying, sampling, and decontamination procedures. Due to the inherent heterogeneous nature of soil and mine waste materials and given the accuracy and precision limitations of laboratory analyses, analytical and physical properties data may show large variabilities. However, the degree of accuracy and precision obtained during the investigation should be sufficient to meet project objectives.

Soil/mine waste samples destined for chemical analysis will be analyzed for parameters listed in Appendix A of the QAPP. The samples will be analyzed for general soil parameters and total concentrations of arsenic, cadmium, chromium, copper, lead, nickel,

and zinc. The method detection limits and analytical methods used for all constituents analyzed are also listed in the project QAPP (Appendix A).

Certain samples will be analyzed for gradation. These samples will be analyzed using procedures described in ASTM D422. Criteria to used for selecting samples for chemical and gradation analysis is described in Section 4.2.6.

4.2 MATERIALS MAPPING AND SAMPLING

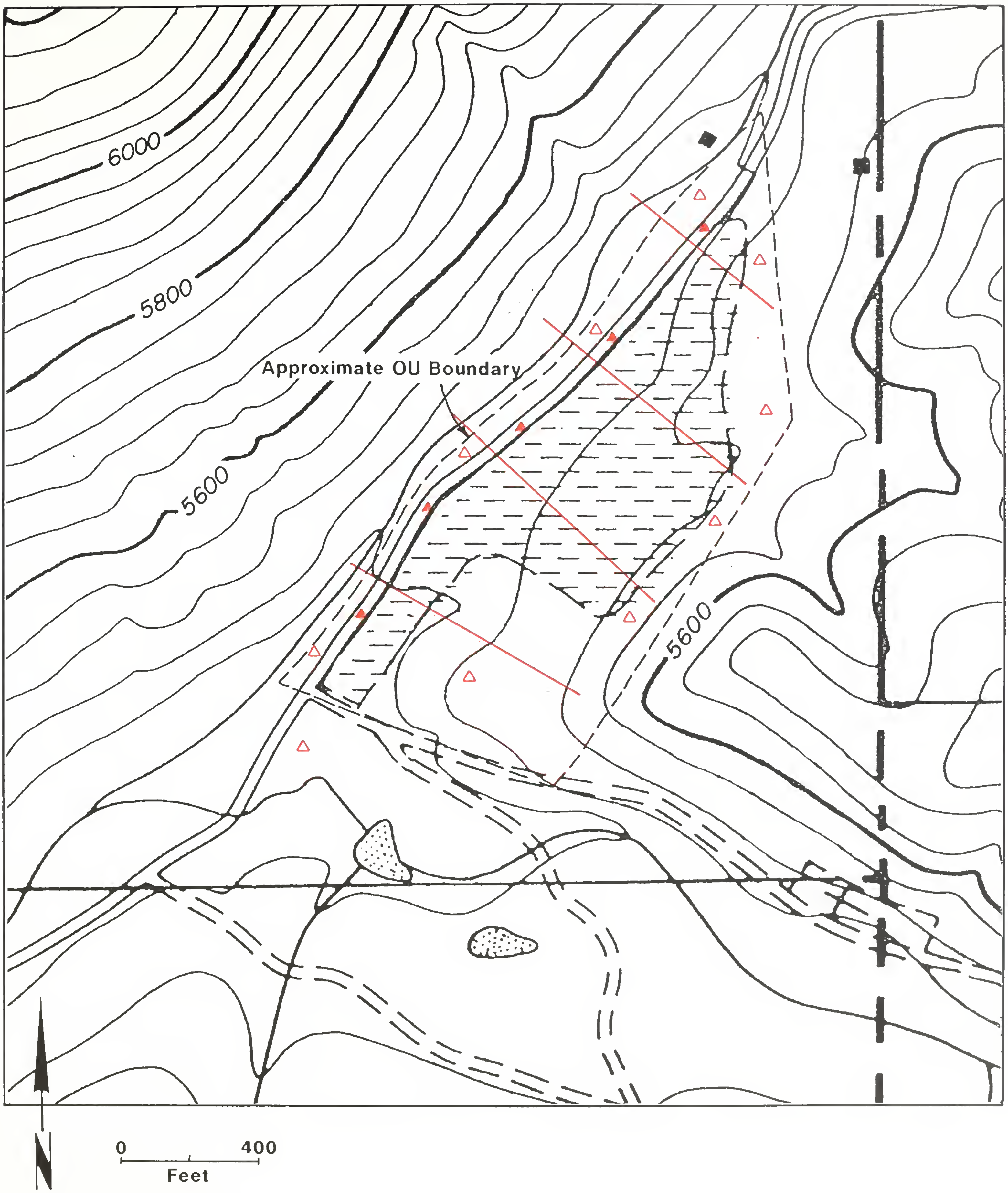
4.2.1 Map Areas

The areas to be mapped during this investigation will generally include the areas within OU boundaries shown on Figures 11 and 12. A buffer area approximately 100 feet wide located outside these boundaries will also be included in the mapping effort.

4.2.2 Mapping Procedures

Field mapping of the extent of tailings and waste rock at the two OUs will be completed by a Chen-Northern scientist. Mapping will be completed on topographic base maps at a scale appropriate to the level of mapping necessary (approximately 1 inch = 500 feet). Mapping will be completed in the field by identifying locations of key features and delineating the extent of obvious tailings and waste rock material on the base maps. The scientist will make necessary notations on the field map and in his field notebook to support the interpretation of the extent of materials mapped.

The field person will use a hand trowel and a soil auger to make periodic inspections of subsurface material in the mapped area. This information will be used to refine map units and mapped areas.



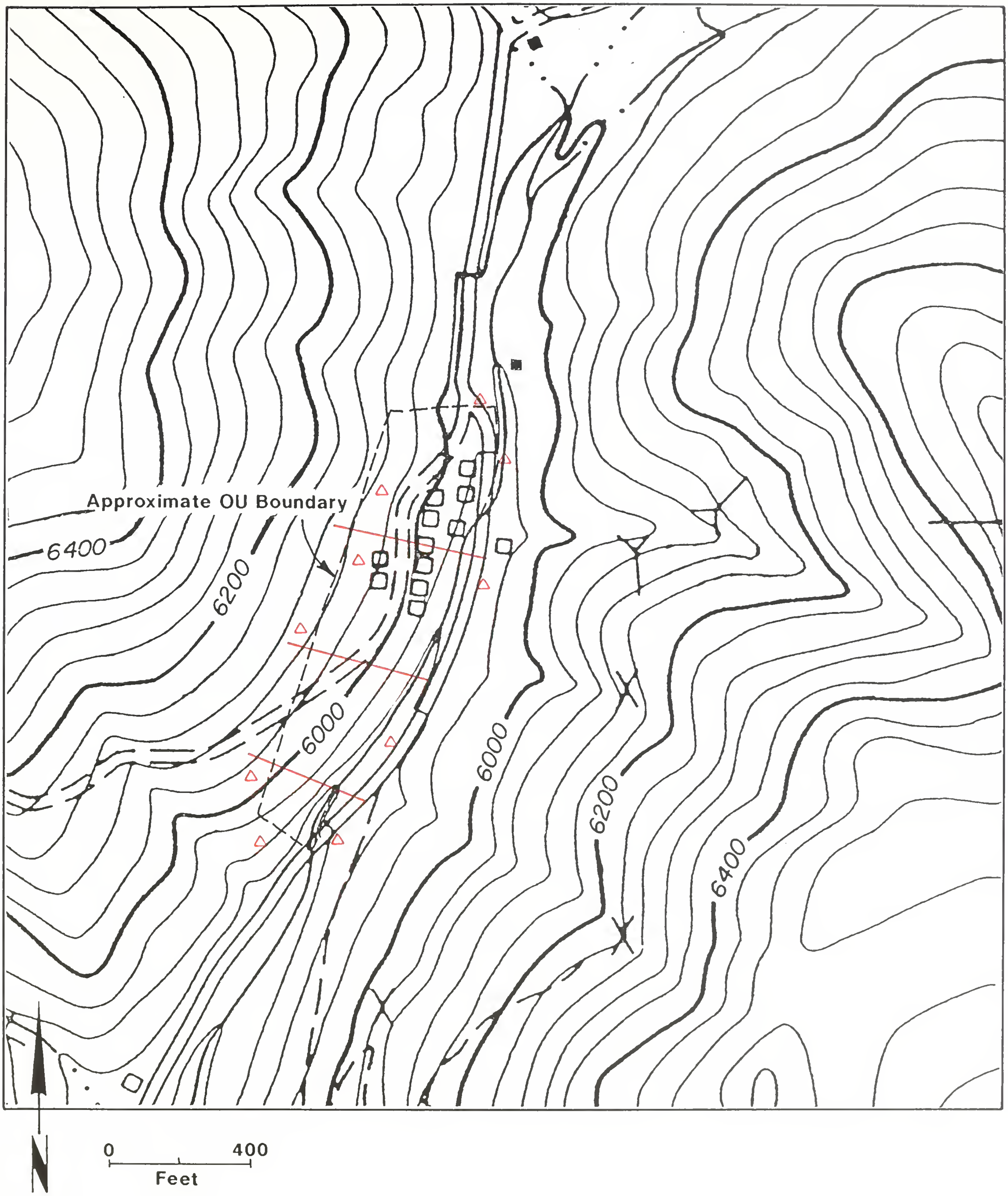
Soil Sample Sites:

△ Chemical Analysis

▲ Gradation Analysis

Cross Section Survey

Mapping, Sampling, and Surveying Locations
Block P Mill Operable Unit
FIGURE 11



Soil Sample Sites:

△ Chemical Analysis

Cross Section Survey

Mapping, Sampling, and Surveying Locations
Block P Mine Operable Unit
FIGURE 12

4.2.3 Sampling Locations, Equipment, and Procedures

A limited number of samples will be collected in conjunction with this portion of the site investigation. Assumed sampling locations are shown on Figures 11 and 12. It is probable that sampling locations may change as a result of observations made in the field during the mapping exercise.

Samples will be collected at locations generally on the fringe of the OUs. Analytical data for material at these locations is necessary to determine the lateral extent of metals-enriched soil. In addition, samples of the berm located between Galena Creek and the Block P Mill OU will be collected to determine its physical properties. Such information is necessary to determine the integrity of the berm during various flood flows in Galena Creek.

Table 4 summarizes the number of samples to be collected during this portion of the investigation and the type of analysis each sample will receive. Listed sample locations and quantities are to serve only as a guide to field sampling teams. Visual observations will be made by the Field Supervisor to determine if additional sites should be sampled or if the number of samples should be increased or decreased.

Field crews will maintain field notebooks throughout the duration of the soil/mine waste sampling period. The field notebooks will be weather-resistant, bound, survey-type books with non-removable pages. Any comments or other notes will be entered directly into the field notebook using permanent, indelible ink. Errors will be lined through and corrected with a new entry. A summary of activities will also be entered into the field book at the end of each field day.

Soil material will be sampled using a bucket auger according to SOP-22 (Appendix A). All sampling equipment will be decontaminated after sampling is completed at a particular sample location. Equipment will not be decontaminated between depth intervals at the same sample location. Decontamination procedures will follow SOP-11 (Appendix A). Decontamination will consist of a Liquinox or equivalent wash, deionized water rinse, dilute nitric acid rinse, and a final deionized water rinse.

TABLE 4
SAMPLES, ANALYSES, PACKAGING, AND SHIPPING REQUIREMENTS
Soil and Mine Waste Mapping Investigation
Block P Mill and Block P Mine Operable Units

ANALYSIS	EST. # OF NATURAL SAMPLES[3]		ASSUMED CONCENTRATION	CONTAINER TYPE	PRESERVATION METHOD	HOLDING TIME
	BLOCK P MILL OU	BLOCK P MINE OU				
Total Metals[1]	10	10	Medium	2-gallon resealable polyethylene bag	None	None
Gradation[2]	5	0	N/A	2-gallon resealable polyethylene bag	None	None

Notes:

1: Analytical methods and detection limits for chemical analyses contained in project QAPP (Chen-Northern, 1990a)
2: ASTM D422.
3: QA/QC samples submitted with each sample set shipped to analytical laboratory will include 2 duplicate samples and 2 blind field standards.

4.2.4 Sample Designation and Frequency

Soil/mine waste samples will be designated as [SS-xxx-yy.y-zz.z] according to the following scheme:

- Sample Type Designation: A [SS] letter designation for soil material sample;
- Sample Location Number: A unique three digit number beginning with 800 to identify the sample location;
- Sample Depth Identifier: Two three-digit numbers indicating the depth interval (in feet and tenths of feet) from which the sample was obtained.

4.2.5 QA/QC Samples

QA/QC samples will be inserted into the sample train at a minimum frequency of 5% of the samples submitted for chemical analysis. These samples will be submitted to the laboratory blind and will include duplicate samples and blind field standards. No cross-contamination blanks will be submitted because of the relatively low likelihood of cross-contaminating soil material samples. Matrix spikes will be prepared by the laboratory for a minimum of 5% of the samples analyzed. Further details regarding laboratory analytical protocol with respect to QA/QC requirements for the project are contained in the project QAPP (Chen-Northern, 1990a).

4.2.6 Sample Selection, Handling, and Analysis

Soil/mine waste samples will be collected in heavy-duty 2-gallon sealable polyethylene bags. A maximum of one gallon of sample will be collected from each depth interval. Sample bags will be marked in indelible ink with the unique sample number, the date, and the time of sampling.

Samples destined for laboratory analysis will be selected based on the following criteria:

- Gradation -- Samples for gradation analysis will be selected based on visual examination of field samples to delineate the horizontal and vertical extent of various textures of material.

- Total metals/pH/EC -- Samples for these analyses will be obtained from the margins of visible tailings and mine waste deposits. Samples will represent the surface (0 to 1 inch) materials and the material directly underlying the surface.

Samples will be placed in coolers and shipped to the analytical or materials laboratory. Chain of custody paperwork will be maintained for all samples collected.

Appendix A of the project QAPP lists analytical parameters, method detection limits, and laboratory methods to be used for material samples. A summary of sample quantities and analysis is listed in Table 4.

4.3 BORROW MATERIAL SOURCE IDENTIFICATION

4.3.1 Field Methods

Potential sources for various types of borrow material will be identified in the field following completion of a literature search to identify locations of these materials. Site inspections will be completed at specific sites identified through the literature search. In addition, a field reconnaissance survey will be completed to identify potential borrow material sources not identified in the available literature.

Field work associated with this work task will be initiated by completing an aerial reconnaissance of the area using DSL's helicopter to identify potential sources and access to identified sources. Field truthing will be completed following the aerial survey to verify the suitability of the material. If a deposit looks favorable, field investigators will make an

estimate of the volume of material and obtain a composite sample for analysis of physical and chemical parameters.

4.3.2 Sampling Equipment and Procedures

Borrow material will be sampled using a bucket auger according to SOP-22 (Appendix A). All sampling equipment will be decontaminated after soil material sampling is completed at a particular sample location. Equipment will not be decontaminated between depth intervals at the same sample location. Decontamination procedures will follow SOP-11 (Appendix A). Decontamination will consist of a Liquinox or equivalent wash, deionized water rinse, dilute nitric acid rinse, and a final deionized water rinse.

4.3.3 Sample Designation and Frequency

Borrow material samples will be designated as [BO-xxx-yy.y-zz.z] according to the following scheme:

- Sample Type Designation: An [BO] letter designation for borrow material sample;

- Sample Location Number: A unique three digit number beginning with 800 to identify the sample location;

- Sample Depth Identifier: Two three-digit numbers indicating the depth interval (in feet and tenths of feet) from which the sample was obtained.A four digit number which indicates the vertical interval sampled.

4.3.4 Sample Handling and Analysis

Borrow material samples will be collected in heavy-duty 2-gallon resealable polyethylene plastic bags. A maximum of one gallon of sample will be collected from each depth interval. Sample bags will be marked in indelible ink with the unique sample number, the

date, and the time of sampling. Samples will be placed in coolers and shipped to the materials laboratory. Chain of custody paperwork will be maintained for all samples collected. A summary of sample quantities and analysis is listed in Table 4.

4.4 SURVEYING

4.4.1 Locations and Frequency

A survey to determine relative elevations of various features will be completed at each OU. Cross sections of existing topography will generally be completed at locations shown on Figures 11 and 12. In addition, elevations of designated measuring points on monitoring wells installed during this study will be determined.

4.4.2 Field Equipment and Procedures

Surveys completed during this investigation will quantify elevations of key features within each OU. Areal locations of such features will be identified on base maps of the OUs. All surveys will be completed in accordance with SOP-29 (Appendix A).

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APPENDIX A

STANDARD OPERATING PROCEDURES
(SOPs)

STANDARD OPERATING PROCEDURE

EQUIPMENT DECONTAMINATION

The purpose of this section is to describe general decontamination procedures for field equipment in contact with mine/mill tailings, soil, or water. During field sampling activities, sampling equipment will become contaminated after it is used. Sampling equipment must be decontaminated between sample collection points if it is not disposable.

Field personnel must wear disposable examination gloves while decontaminating equipment at the project site. Change gloves between every sample. Every precaution must be taken by personnel to prevent contaminating themselves with the wash water and rinse water used in the decontamination process.

Table A-1 lists equipment and liquids necessary to decontaminate field equipment.

The following should be done in order to complete thorough decontamination:

1. Set up the decontamination zone approximately 15 feet upwind from the sampling area. This area will be designated by the field crew leader.

2. Visually inspect sampling equipment for contamination; use stiff brush to remove visible material.

3. The general decontamination sequence for field equipment includes: wash with Liquinox or its equivalent; DI water rinse; dilute nitric acid rinse; DI water rinse; rinse with sample water three times.

4. Rinse equipment with methanol in place of the nitric rinse if sampling for organic contamination. Follow with a DI water rinse.

5. Decontaminated equipment that is to be used for sampling organics should be wrapped in aluminum foil if not used immediately.

6. Clean outside of sample container after filling.

Alternatively, field equipment can be decontaminated by steam cleaning, rinsing with dilute nitric acid, and rinsing with deionized water.

All disposable items (e.g., paper towels, examination gloves, wash cloths) should be deposited into a garbage bag and disposed of in an approved landfill. Contaminated wash water does not have to be collected.

If vehicles used during sampling become contaminated, wash both inside and outside as necessary.

TABLE A-1. EQUIPMENT LIST FOR DECONTAMINATION

2-gallon plastic tubs	Liquinox (soap)
5-gallon plastic water-container	Hard bristle brushes
5-gallon carboy DI water	Garbage bags
1-gallon cube of 10% HNO_3	Latex gloves
Paper towels	Squeeze bottles
	Methanol

STANDARD OPERATING PROCEDURE

QC SAMPLES

QC samples do not have any unique identifying codes that would enable the contract lab or others to bias these samples in any way. There are, however, differences in blank and standard samples which might separate them from the rest of the sample train. The sampling team will strive for uniformity in sampling technique to limit sampling error. The QC samples will be identified only on the SAMPLE IDENTIFICATION MATRIX. The codes on the matrix sheet are as follows.

N - Natural Sample
R - Replicate - Duplicate Sample
BB - Bottle Blank
WB - Cross Contamination Blank
BFS- Blind Field Standard
KB - Kimwipe Blank
TB - Travel Blank

In general, QC samples will be inserted into the sample train on a one in twenty basis or one per day per sampling crew, whichever results in more QA/QC samples.

1. A duplicate sample will be a second sample taken from the same media at the same time.

2. A bottle blank will be deionized water placed directly into the sample bottles. It is preferable to fill bottle blank off-site.

3. A cross contamination blank will be deionized water run through all sampling equipment or a Kimwipe wiped over decontaminated equipment and then placed into sample bottles.

4. A field standard will be an EPA approved standard prepared in the laboratory and entered into the sample train.

5. A Kimwipe blank will be a Kimwipe obtained directly from its packaging and inserted into a sample container.

6. A travel blank will be a ultra pure water sample prepared at the analytical laboratory and shipped to the sampling team; the blank must travel in a cooler with the sampling team when sampling for volatile organic compounds.

Each field crew leader will be responsible for all QC samples prepared by that crew.

STANDARD OPERATING PROCEDURE

MONITORING WELL CONSTRUCTION

1. Arrive on-site with properly sized drilling equipment and materials for site conditions. All drilling equipment and materials should be properly decontaminated prior to its arrival on-site. Decontamination usually includes steam - or hot water-cleaning methods.

2. Drilling muds or drilling solutions of any kind are not to be used during drilling activities in conjunction with monitoring well construction. Acceptable drilling techniques include air-rotary, cable tool, or hollow-stem auger. If unconsolidated material is encountered, it may be necessary to drive steel casing during drilling to maintain borehole integrity. It is suggested threaded steel casing be used in lieu of welding joints together to minimize this source of potential well contamination. Hydraulic jacks or the drill rig can be used to pull back the steel casing following emplacement of plastic casing.

3. A detailed lithologic log shall be completed during drilling activities. Water bearing characteristics of the formations should also be denoted on the log. In addition, details of monitoring well construction should also be described on the well log including total depth, perforated interval, sizes and types of construction materials, etc.

4. Seven- or ten-inch outside diameter hollow-stem augers can used in drilling shallow exploration drill holes in many situations. Care is taken to avoid contamination due to oil and grease from the drill rig and split spoon sampler. Appropriate decontamination of the drill rig between drill holes is performed. Soil and sediment samples are collected using a standard 1.4 inch inside diameter split spoon sampler and a 140 pound drive hammer. The number of blows necessary to obtain an 18 inch length of sample is recorded on the exploration log. Appropriate decontamination of the split spoon sampler is accomplished between samples.

   Either a single- or multi-completion monitoring well can be constructed in a single borehole where hollow-stem auger drilling is not used. Backfill chemically-inert silica sand to above the perforated interval and emplace a bentonite plug above the sand following installation of factory-screened and blank PVC (stainless steel or PTFE for organics) well casing into the borehole. Where appropriate, begin pulling temporary steel casing out of borehole. Emplace silica frac sand about any other perforated sections in the borehole; install bentonite plugs above and below perforated sections. Backfill remaining well annulus with a bentonite slurry or with grout to the surface.

5. Place locking well protector over PVC casing(s) after outer steel casing has been removed from the borehole if necessary. Place bentonite plug below bottom of well protector; grout well protector in place and lock with high quality lock.

STANDARD OPERATING PROCEDURE

GROUND WATER SAMPLING

1. Inspect all sampling equipment for damage upon arriving on-site. Repair equipment as necessary.

2. Decontaminate sampling equipment by scrubbing with brush and Liquinox, solution, rinsing with dilute nitric acid, and rinsing with deionized water.

3. Sampling domestic wells:

    a. Turn-on household fixture (preferably outside faucet) and allow well to discharge for 5 to 10 minutes. Be certain discharge point is on the well-side of any water conditioning device or screen.

    b. Monitor field parameters periodically during discharge period. When field parameters are within plus or minus five percent over three consecutive readings, the well is ready for sampling.

    c. Fill sample containers and add sample preservatives as appropriate. Do not collect samples through rubber hoses. Samples should be collected directly from hydrant or faucet. Perform field parameter tests.

    d. Field filter sample water in accordance with SOP-04 if appropriate. Add preservations as appropriate.

    e. Complete field forms in accordance with SOP-10.

4. Sampling monitoring wells:

    a. Evacuate monitoring wells with bailer or pump; monitor field parameters for consistency during evacuation process. Remove a minimum of three bore volumes of water from the monitoring well.

b. Following well evacuation, install decontaminated bladder pump into or above perforated zone in well; commence pumping and monitor field parameters for consistency using field parameter box. Alternatively, a decontaminated bailer may use to collect the sample. Well is ready for sampling when field parameters are within plus or minus five percent on three consecutive readings.

c. Field filter sample water in accordance with SOP-04 if appropriate. Add sample preservatives as appropriate; fill out field forms in accordance with SOP-10.

STANDARD OPERATING PROCEDURE

FIELD MEASUREMENT OF GROUND WATER LEVEL

1. Check well probe prior to leaving for field for defects. Repair as necessary. Make certain the well probe, a decimal tape measure and extra batteries are in the carrying case.

2. Measure all wells (monitoring and domestic) from the top of the well casing on the north side or from a designated measuring point, as appropriate. Measure and record distance from measuring point to ground level.

3. Obtain a depth to water from measuring point to the nearest hundredth of a foot. Record data on appropriate field forms.

4. Decontaminate well probe between each measurement by scrubbing with Liquinox and brush, then rinsing with deionized water.

5. Calibrate well probe to a steel tape prior to and following each data gathering episode. Note any corrections to well probe measurements on field forms. Adjust reported data as necessary.

STANDARD OPERATING PROCEDURE

SOIL SAMPLE COLLECTION AND HORIZON DESCRIPTION

SURFACE SAMPLING

Surface soil/tailings samples are collected from the surface to a depth of one inch. Sufficient sample will be collected for the analysis that will be performed. Soil descriptions will be completed for each collected soil sample in accordance with the procedures outlined in the unified soil classification system (ASTM D2487). Descriptions shall be recorded in field books or on standard morphological description logs.

Each sample will be deposited directly onto a plastic sheet. The sample will be broken up. A representative sample will be obtained by alternately pulling one corner of the plastic sheet over the opposite corner a minimum of 25 times. The sample will then be transferred to the appropriate container.

When sampling soil for organics the samples will be deposited directly into the sample container for shipment to the laboratory without mixing.

All equipment used in the sampling of surface soils will be decontaminated using the procedures in SOP-11. All necessary paperwork will be filled out in accordance with SOP-12.

SUBSURFACE SAMPLING

Subsurface sampling will be completed using either a bucket auger or a split spoon sampler. Sampling procedures using these types of equipment is described below:

Bucket Auger

1. Arrive on-site equipped with a stainless steel auger rod and four sizes of stainless steel augers (e.g. 2-inch, 4-inch, 6-inch, and 8-inch).

2 Decontaminate augers and handle using methods described in SOP-011 or with a steam cleaner followed with dilute nitric acid and deionized water rinses.

3. Using largest auger, drill down a maximum of three feet in six inch increments, salvaging material as augering proceeds. Install temporary decontaminated PVC casing with a diameter slightly smaller than borehole. Using the next size smaller bucket auger, repeat the process. This telescoping procedure will minimize cross contamination of the various lithologies encountered in the soil profile.

4. Select sample intervals for packaging for laboratory analysis in accordance with procedures described in the project work plan or sampling and analysis plan. Composite and mix subsamples; obtain a portion of composited sample for XRF determinations or other needs.

5. Fill out appropriate paper work and bottle labels as necessary prior to leaving site.

6. Decontaminate all equipment between sample locations.

Split Spoon Sampler

1. Arrive on-site equipped with at least two standard 1.4 inch inside diameter split spoon samplers. If geotechnical information is desired, a 140 pound drive hammer is required.

2. Decontaminate split spoon sampler in accordance with SOP-011 or with a steam cleaner and dilute nitric acid and deionized water rinses.

3. Install sampler into borehole until the top of the undrilled formation is encountered. Using 140 pound drop hammer or by other means, hammer split spoon sampler into formation approximately 18 inches. Record number of blow counts to complete sampling over each 18-inch interval, as necessary. Retrieve sampler and place on work table. Using the other sampler, repeat this sequence.

4. Record lithology and percent recovery from cores retrieved from split spoon sampler.

5. Based upon the project work plan or sampling and analysis plan, composite like core intervals. Mix sample thoroughly and obtain a subsample for XRF and field parameter determinations as necessary.

6. Decontaminate sampling equipment between each interval sampled and between sampling sites.

STANDARD OPERATING PROCEDURE

AQUIFER TESTING

Pumping Tests

1. Measure water levels in the pumping well and all observation wells daily for several days prior to the test to document water table fluctuation. It is preferable to install a continuous water level recorder to obtain this information.

2. Arrive on-site with all necessary equipment decontaminated and in good repair.

3. Set-up equipment; insure discharge hose/piping is directed away from test area such that the discharge will not influence the test. Obtain any necessary sanitary sewer or other discharge permits.

4. Choose pump size based on expected well yield reported from previous pumping tests or from the well development logs. It is important to stress the aquifer during the pumping test yet have enough available drawdown for the expected duration of the test.

5. Obtain water level data prior to the test in the pumping well and in all observation wells. Record all data on standardized field forms.

6. Begin trial pumping test by maintaining a constant discharge rate and measuring drawdown in the pumping well with an electric well probe or a pressure transducer. Determine if pumping rate is appropriate for the length of the test. Adjust discharge rate as necessary. Terminate trial test and allow water levels to recover to prepumping elevations.

7. Prepare for constant discharge test by coordinating all personnel involved. Collect water level data every 30 seconds for the first five minutes of the test, every minute for the next five minutes, every two minutes for minutes 10 through 20 of the test, every five minutes for minutes 20 through 40, every 10 minutes for minutes 40 through 60, every 15 minutes for minutes 60 through 100, every 30 minutes for minutes 100 through 1000, and every 60 minutes for the remainder of the test. Following termination of the constant discharge test, collect water level recovery data in a sequence similar to that above with the most frequent measurements obtained early in the recovery tests.

8. During the constant discharge test, obtain measurements of discharge periodically and record on field forms. Adjust discharge as necessary to maintain consistency. Measure field parameters, including pH, SC, and temperature at the time of discharge measurements.

9. Record all data on standard field forms and plot drawdown and recovery curves in the field in accordance with methods described in Lohman (1972) or other appropriate techniques as conditions or aquifer type warrant. Note any irregularities in the test on field forms.

10. Upon completion of aquifer testing, decontaminate all equipment prior to exiting the project area.

Reference:

Lohman, S.W. 1972. Ground Water Hydraulics. U.S. Geological Survey Professional Paper 708. Washington.

<u>Slug Testing</u>

1. Arrive on-site with all equipment decontaminated and in good repair.

2. Insert pressure transducer (if applicable) into well to be tested and allow to stabilize. Measure and record static water level prior to initiation of test.

3. Perform test by either withdrawing a known volume of water or inserting a cylinder of know dimensions. Record water level recovery data at frequent intervals on a standardized field form. Measurement frequency should continuously initially, decreasing to every five minutes after approximately 15 minutes into the test. It is preferable to use a continuously recording pressure transducer to record recovery data as data obtained early in the test are typically the most valuable data for slug testing. Record data until recovery is about 95 percent complete.

4. Analyze recorded data in the field in accordance with procedures described in U.S. Department of the Navy (1974), Hvorslev (1951) and/or any other appropriate techniques for the type aquifer being tested.

5. Note any irregularities in test procedures on the field forms.

6. Decontaminate all field equipment prior to leaving each site.

References:

Hvorslev, J.M. 1951. Time lag and soil permeability in ground water observations. Bulletin 36. U.S. Corps of Engineers, Waterways Exp. Sta., Vicksburg, MS.

U.S. Department of the Navy. 1974. Naval Facilities Engineering Command

STANDARD OPERATING PROCEDURE

FIELD SURVEYING

1. Identify locations of USGS or NGS benchmarks proximal to the study area.

2. Establish at least two bench marks on or near the study area; these are typically established by driving a spike into a telephone pole or by clearly marking a permanent landmark.

3. Establish the relationship between bench marks established near the study area and any identified USGS or NGS benchmarks both vertically and horizontally.

4. Establish horizontal control points throughout the area of interest at key locations. Establish relationship between control points using the direct and reverse horizontal and vertical angle methods.

5. Survey desired points (e.g. soil sample locations, monitoring well measuring points) using the direct and reverse horizontal and vertical angle methods. Obtain an accuracy of plus or minus 0.1 feet vertically and plus or minus one foot horizontally.

6. Record all data collected in a standardized format in the project field book.